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ARTICLES

THE OPERATION AND PHYSICAL EVALUATION OF ROUTINE APPLICATIONS OF DDT LARVICIDES BY AIRPLANE *

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AND
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INTRODUCTION

Experimental studies were conducted at the Savannah Wildlife Refuge during 1946,[1, 2] to determine the effects on wildlife of routine applications of DDT larvicides by airplane as spray and as exhaust aerosol. This paper deals with the operational factors and the physical evaluation of the distribution and recovery of DDT on the water surface.

DISPERSAL EQUIPMENT

Two Army-type PT-17 airplanes were used for the distribution of DDT in the form of spray and of exhaust aerosol. Krusé and Metcalf [3] and others [4] have described the basic equipment for these aircraft. Each airplane was furnished by the Tennessee Valley Authority with essentially the following equipment: a 33-gallon-capacity solution tank mounted in the rear cockpit, a propeller-driven pump unit mounted on the footwalk of the lower left wing, a relief valve with pressure adjustment screw to regulate solution pressure, five hollow cone atomizing nozzles (Spraying Systems Co. Nozzle No. ¼ LN12) for wing sprays, an exhaust pipe extension with venturi containing two flat atomizing nozzles (Spraying Systems Co. Nozzle No. ¼ T8006) which sprayed the larvicide into the throat section for aerosol dispersal, and shut-off valves controllable from front cockpit for the spray and aerosol systems.

In order to obtain accurate quantitative data on solution output for short test runs, a flow meter which registered to 0.02 gallons was installed on one of the airplanes. The meter, Hersey Model GB ⅝" size, was of the wobble plate type normally used for measurement of fuels and water. Installation was on the discharge line of the solution pump with mounting behind the pump on the footwalk of the lower left wing. A 70 x 80 mesh screen strainer was also connected in the discharge line between the meter and the spray nozzles. The tap for pressure gauge was installed downstream in order to obtain as nearly as practicable the true nozzle pressures. A metal gauging stick readable to 0.1 gallon was calibrated to serve as a check on the meter. To protect the fuselage interior from spillage of spray solutions, an aluminum sheet metal cover was installed on the rear cockpit. The rear windshield was removed and the filler neck extended through the cover. The cover facilitated cleaning and tended to streamline the fuselage.

By a series of test flights it was found that the normal cruising speeds of the two airplanes were both about 90 miles per hour. Based on 100 ft. swath widths, an area of approximately 18.2 acres was treated per minute of discharge. A 20 per cent (by weight) solution of technical DDT in *Velsicol NR-70* * was employed

* From Communicable Disease Center, Technical Development Division (Savannah, Georgia).

* *Velsicol NR-70*, a polymethylated naphthalene, is a solvent produced by the Velsicol Corp., Chicago, Ill.

in all of the treatments. Each gallon of solution contained approximately 1.85 lbs. DDT. Since an output of 0.1 lb. DDT per acre was desired for the experiments, the solution discharge rate of one gallon per minute was used for calibration of nozzle output.

The exhaust venturi as originally designed for the PT-17 airplane was of 4-inch diameter with 2-inch throat diameter and 22½-inch long discharge section. Following later recommendations from the Tennessee Valley Authority, the discharge section of the venturi was reduced in length to 10 inches. No significant change in performance was observed.

An attempt was made to obtain a more uniform distribution of spray drops by use of different nozzles and nozzle arrangements. There was no apparent improvement; therefore, the five Spraying Systems No. ¼ LN12 Nozzles were used for all of the spray treatments described in this paper.

METEOROLOGICAL OBSERVATIONS

A portable weather tower 6½ feet tall was constructed to facilitate accurate measurement of essential meteorological variables during tests. Air temperatures were observed at 6 feet and 1 foot above ground level using paired mercury thermometers shielded from the direct radiation of the sun. Average wind velocities were secured over one minute periods with a 4-inch diameter pinwheel anemometer at the 6 foot level. A sensitive vane with removable pivot was mounted on the top of the tower for observation of wind direction. The difference in temperature of the air at 6 feet and 1 foot above ground was an indication of vertical thermal air movement. Downward air movement occurred during a condition known as "inversion" (T_6–T_1, a plus value). Thermal upward movement of air normally occurred during a condition of "lapse" (T_6–T_1, a negative value). It is generally accepted that best deposition of small spray or aerosol drops is obtained during conditions of "inversion."

METHODS OF EVALUATING DEPOSITED DDT

For proper evaluation of airplane dispersal of DDT, it was necessary to know not only the amount of DDT put out by the airplane but also the amount of DDT deposited on the ground or water surface. Preliminary investigations on the distribution of DDT-oil droplets from the airplane were made by measuring the ground deposition at sampling points arranged at 20- or 25-foot intervals in two or three lines perpendicular to the line of flight. Each line of sampling stations was about 100 feet apart, and the values for the corresponding stations in each line were averaged. The mass median diameter of the oil droplets and the area dose of DDT deposited were determined by microscopic counting of the oil droplets collected on carbon-coated slides, which were placed horizontally on the ground at each sampling point.

All tests were made just after dawn when conditions of inversion were most prevalent. Flights were made at a height of 20 to 30 feet, and tests were made with the airplane flying both directly into the wind and perpendicular to the wind. Multiple swath flights were also made to determine the effect of overlapping of swaths.

During the routine dispersal of DDT at the Savannah Wildlife Refuge, the evaluation of the amount of DDT actually deposited on the water surface was determined by chemical analysis of DDT deposited on 3 x 12 inch glass panels. On each of the treated ponds, twelve stakes arranged at 30- or 40-foot intervals in a "horseshoe type" pattern were used as sampling stations. Two dikes along the ponds were also selected for sampling stations, and six stations at various intervals were placed on each dike. A 6 x 15-inch wood platform was nailed on top of each stake to hold the glass panel.

Initially, it was desired to use carbon-coated slides to sample the deposited DDT-oil droplets, with only an occasional check by actual chemical analysis of DDT. Because of the time required to place

slides or glass panels on each of the four ponds and two dikes, it was necessary to place them on the stations the day before the actual airplane treatment, which occurred at dawn. Heavy dew or rain ruined many of the carbon-coated slides, and this method of analysis had to be abandoned in favor of quantitative chemical analysis of DDT. The analytical procedure used was a modification of the Schechter, et al.,[5] and the Bent[6] colorimetric methods of analysis for DDT. Acetone was used to wash the DDT from the panels into beakers, and the desired aliquot portion was taken for analysis. Considerable experience in judging the amount of oil-droplets on the glass panels was necessary in order to select the most convenient size portion for analysis of DDT. Special boxes, similar to a microscope slide box, were constructed to hold the 3- x 12-inch glass panels during transportation from the ponds to the laboratory.

DISTRIBUTION OF DDT

Factors which were of primary importance in affecting the distribution of DDT from the airplane were the size of oil-droplets, elevation of airplane, and meteorological conditions, especially wind velocity. With wind velocities of less than 2 miles per hour, it was quite common for the direction of the wind to change as much as 90 degrees in a few seconds. Under practical field conditions it was not feasible for the airplane to fly in any one direction in relation to the wind direction. Thus, the distribution of DDT was determined with the airplane flying both directly into the wind and perpendicular to the wind.

Typical single swath distributions of DDT from the airplane are presented in Figures 1 and 2. On the basis of a 100-foot swath width, a minimum dosage of 0.002 lb. DDT/acre was recovered from aerosol applications, with flights into the wind, and a minimum dosage of 0.003 lb.

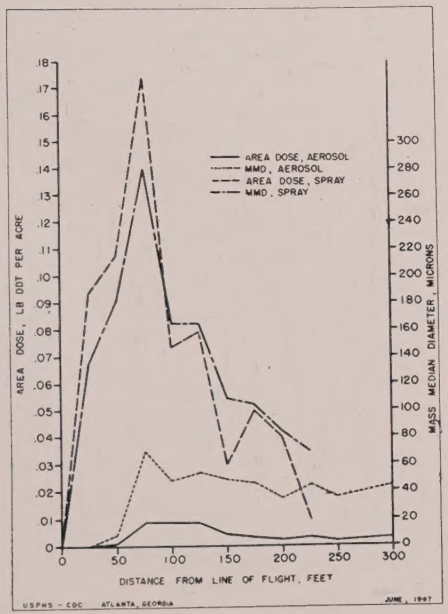

FIGURE 1. Typical distribution of DDT as thermal aerosol and spray by airplane which flew into a 2 mph wind.

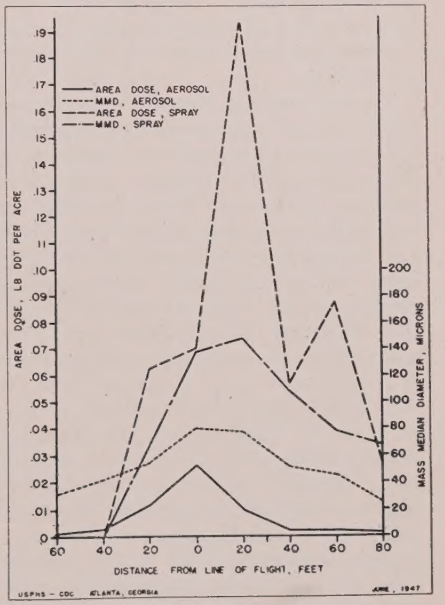

FIGURE 2. Typical distribution of DDT as thermal aerosol and spray by airplane which flew perpendicular to a 5 mph wind.

DDT/acre for flights perpendicular to the wind. The maximum recovered dosage from the aerosol was about three times greater for flights into the wind than for flights perpendicular to the wind direction. However, on flights perpendicular to the wind direction, a dosage of 0.002 lb. DDT/acre was maintained for about 250 feet. The mass median diameter of the oil-droplets from the aerosol ranged from about 40 microns to 80 microns. On the basis of a 100-foot swath width the spray produced a minimum recovered dosage of 0.03 lb. DDT/acre for flights into the wind, and a minimum recovered dosage of 0.07 lb. DDT/acre for flights perpendicular to the wind. The distribution of DDT from the spray was quite similar for both flights into the wind and perpendicular to the wind. Very large maximum dosages of from 0.17 to 0.19 lb. DDT/acre were obtained in each case. The mass median diameter of the oil-droplets from the spray ranged from about 60 microns to 280 microns. A very close correlation between the mass median diameter and the area dose was obtained for both sprays and aerosol.

Typical multiple swath distribution of DDT with the airplane flying perpendicular to the wind direction is presented in Figure 3. The airplane made four parallel swaths at 100-foot intervals, as indicated by the diagram in Figure 3. In such flights, the swaths are started at the downwind side, in order that succeeding swaths may be made without flying into the oil-droplets from previous swaths. At the end of a swath, the airplane turns slightly downwind to make the turn for the next swath. Such a flight pattern prevents the airplane and pilot from becoming contaminated with the insecticide being dispersed. The sampling station at 325 feet received the greatest dosage of DDT, as it was the point of maximum deposit from swath No. 1, and material from the other three swaths added to the total deposit. The 100-foot width which had the maximum deposit of DDT occurred at points which received driftage of DDT from 2 to 3 succeeding swaths. In this 100-foot width, the spray had a minimum recovered dosage of 0.08 lb. DDT/acre and the aerosol had a minimum recovered dosage of 0.012 lb. DDT/acre. The spray generally showed a peak deposition of DDT at 25 feet downwind from the lines of flight and a marked reduction in deposition of DDT at 75 or 100 feet from the lines of flight. The aerosol did not have as large a variation in deposition of DDT as the spray, but the recovered dosage was much smaller for the recovered dosage than the spray.

TREATMENT OF THE SAVANNAH WILDLIFE REFUGE

Weekly treatment of four Savannah Wildlife Refuge pools for studies on the effects of DDT on aquatic and terrestrial forms of life was begun on May 1, 1946. In order to treat the pools with spray under similar conditions, two airplanes were used until mid-season. One airplane

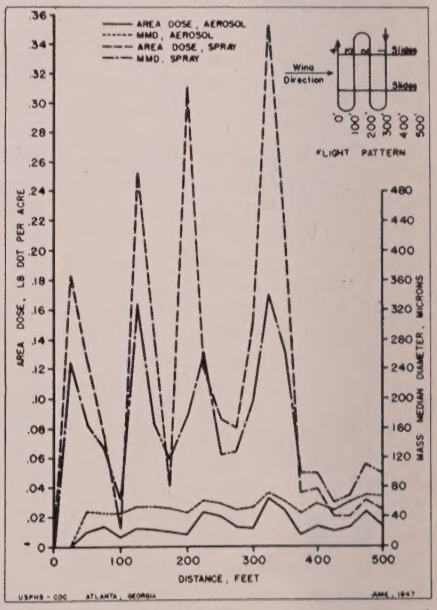

FIGURE 3. Typical multiple-swath distribution of DDT as thermal aerosol and spray by airplane which flew perpendicular to a 5 mph wind.

applied spray to pool 6 (270 acres) * and pool 2 (185 acres) while the other dispersed the exhaust aerosol to pool 3A (120 acres) and pool 3 (240 acres). As one of the airplanes with pilot was transferred to another project during the latter portion of July, it was necessary to make the last six weekly treatments with one airplane. The following procedure was then employed: starting at dawn treat pools 3 and 3A with aerosol, return to airport for metering and refilling of solution tanks, and then spray pools 2 and 6.

The output dosage for both spray and aerosol was 0.1 lb. DDT per acre, employing the solution containing 20 per cent (by weight) DDT in *Velsicol NR-70*. Applications were made at an elevation of about 30 feet wherever possible, and roughly 20 feet above trees and other obstructions. Uniformly spaced and parallel swaths of 100-foot width were obtained by using existing landmarks and twenty-five 4- x 4-feet yellow markers strategically placed for guidance of the pilot. The markers were installed at 500-foot intervals perpendicular to the line of flight. The pilot flew over a marker for his first, sixth, eleventh, etc., swath with satisfactory spacing of intermediate swaths. To minimize flight hazards, it was necessary to remove several tall dead trees from pools 6 and 3A.

The usual treatment time for pools 6 and 2 was about 27 minutes each or a total of approximately 55 minutes. Pools 3 and 3A were treated as a unit and normally required 45 to 50 minutes for application.

The thermal condition of "inversion" (T_6–T_1 a plus value) occurred only 30 to 40 minutes following sunrise. A portion of the treatment was applied with thermal upward movement of air. Furthermore, the wind velocity increased from about 2 mph to 3 mph during period of treatment. These conditions were considered good for general treatment. It was sometimes necessary to apply the sprays and aerosols with severe conditions of lapse and wind velocities up to 6 mph.

Pools 3 and 3A each received 15 aerosol applications for a total output dosage of 1.60 pounds DDT per acre. Pool 2 was sprayed 16 times and pool 6 received 17 spray treatments for total output dosages of 1.54 and 1.64 pounds DDT per acre, respectively. The average output dosages per treatment were therefore 0.107 pounds DDT per acre for the aerosol pools and 0.093 pounds DDT per acre for the spray pools.

Recovery of DDT at the Water Surface

The recovery of DDT from both the thermal aerosol and the spray at twelve sampling stations in each treated pool at the Savannah Wildlife Refuge furnished data that could be subjected to analysis of variance.

Both pools 3 and 3A, which were treated with the thermal aerosol, showed variation of the mean recovered dosage of DDT from week to week which far exceeded the 1 per cent level of significance. The recovered dosage from week to week varied from 0.008 to 0.030 pounds DDT per acre on pool 3 and from 0.005 to 0.032 pounds DDT per acre on pool 3A. Since the recovered dosage of DDT was quite low, ranging from 5 per cent to 25 per cent of the applied dosage, the magnitude of the variation from week to week was small, but the variation was much greater than the random sampling error. The mean recovered dosage at twelve sampling stations varied from 0.008 to 0.017 pounds DDT per acre on pool 3 and from 0.006 to 0.017 pounds DDT per acre on pool 3A, but the variation was not significantly greater than the random sampling error. Thus, the distribution of DDT deposited on the water surface from the thermal aerosol was quite uniform, but the different meteorological conditions encountered caused a significant change in the mean

* Treatment area included the pool area plus a strip approximately 100 feet wide around the pool.

recovered dosage of DDT from week to week.

On the pools which were treated with the spray, the mean recovered dosage of DDT from week to week varied from 0.038 to 0.096 pounds DDT per acre on pool 6 and from 0.037 to 0.091 pounds DDT per acre on pool 2. Although the range of variation was practically the same, only on pool 6 was the variation equal to the 1 per cent level of significance. The mean recovered dosage for the spray was quite high, ranging from 37 per cent to 96 per cent of the applied dosage. The mean recovered dosage of DDT at twelve sampling stations varied from 0.031 to 0.078 pounds DDT per acre on pool 6 and from 0.041 to 0.124 pounds DDT per acre on pool 2. The variation between stations on pool 2 almost reached the 5 per cent level of significance, while on pool 6, the variation between stations was not significantly greater than the random sampling error. The random sampling error for pool 2 was very large and prevented the large variation between weeks and between stations from being statistically significant. Probably the physical characteristics of the two pools influenced the variation of recovered dosages of DDT considerably. Pool 2 had a large amount of "saw-grass" over the entire area but was otherwise free from trees and other obstructions. Pool 6 was practically open water but was bordered by a dike which had high trees at several places. The data for pool 2 on July 9, 1946 offers an example of the wide range in the amount of DDT deposited on the water surface by the spray for a single treatment. The extreme variation between stations, which were 30 or 40 feet apart, was more than 20 fold. The distribution of DDT on the water surface was spotty, i.e., a heavy dosage of DDT was deposited in one place, and 40 feet or more away, a very light dosage of DDT was deposited.

The recovered dosage of DDT was less along the dikes than on the water surface for both the spray and the thermal aerosol. The mean recovered dosage of DDT along the dike of pool 6, which was treated with the spray, was 0.046 pound DDT per acre or 49 per cent recovery of the applied dosage. The mean recovered dosage of DDT along the dike of pools 3 and 3A, which was treated with the thermal aerosol, was 0.008 pounds DDT per acre or 8 per cent recovery of the applied dosage.

The recovered dosage from the spray was significantly greater than the recovered dosage from the thermal aerosol. The magnitude of the variation at twelve sampling stations was greater for the spray than for the aerosol, but the variation between stations did not reach the 5 per cent level of significance for either the spray or the thermal aerosol. The marked difference in recovery of DDT on the water surface from the spray and from the thermal aerosol is shown in Figure 4.

SUMMARY

Routine application by airplane of DDT larvicides in the form of spray and exhaust aerosol was made for experimental studies on the effect of DDT on wildlife. The equipment and operational procedure for airplane dispersal of DDT are described.

Examples of typical distribution of DDT as both spray and exhaust aerosol are graphically shown.

The recovery of DDT at the water surface of pools at the Savannah Wildlife Refuge is summarized, and the results of analysis of variance are discussed. The distribution of DDT at the water surface was more uniform from the aerosol than from the spray; however, the average recovered dosage of DDT was about 4 to 6 times greater from the spray than from the aerosol.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to the following members of the Technical Development Division of the Communicable Disease Center, U. S. Public Health Service: J. W. Taylor and Leroy Johnson who piloted the airplanes;

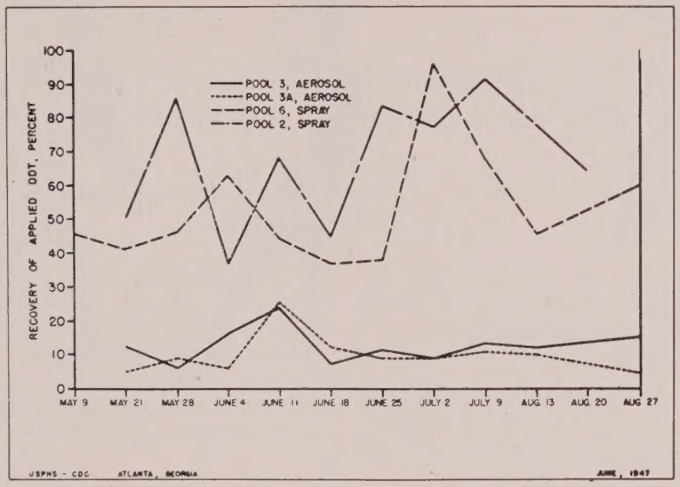

FIGURE 4. Average recovery of DDT at the water surface from the thermal aerosol and spray during the season.

M. B. Goette, S. B. Richter, and S. L. Resnick who aided in the chemical analysis for DDT; Dr. W. M. Upholt who was very helpful in the statistical analysis of the data; and especially Dr. S. W. Simmons whose direction and advice made these studies possible.

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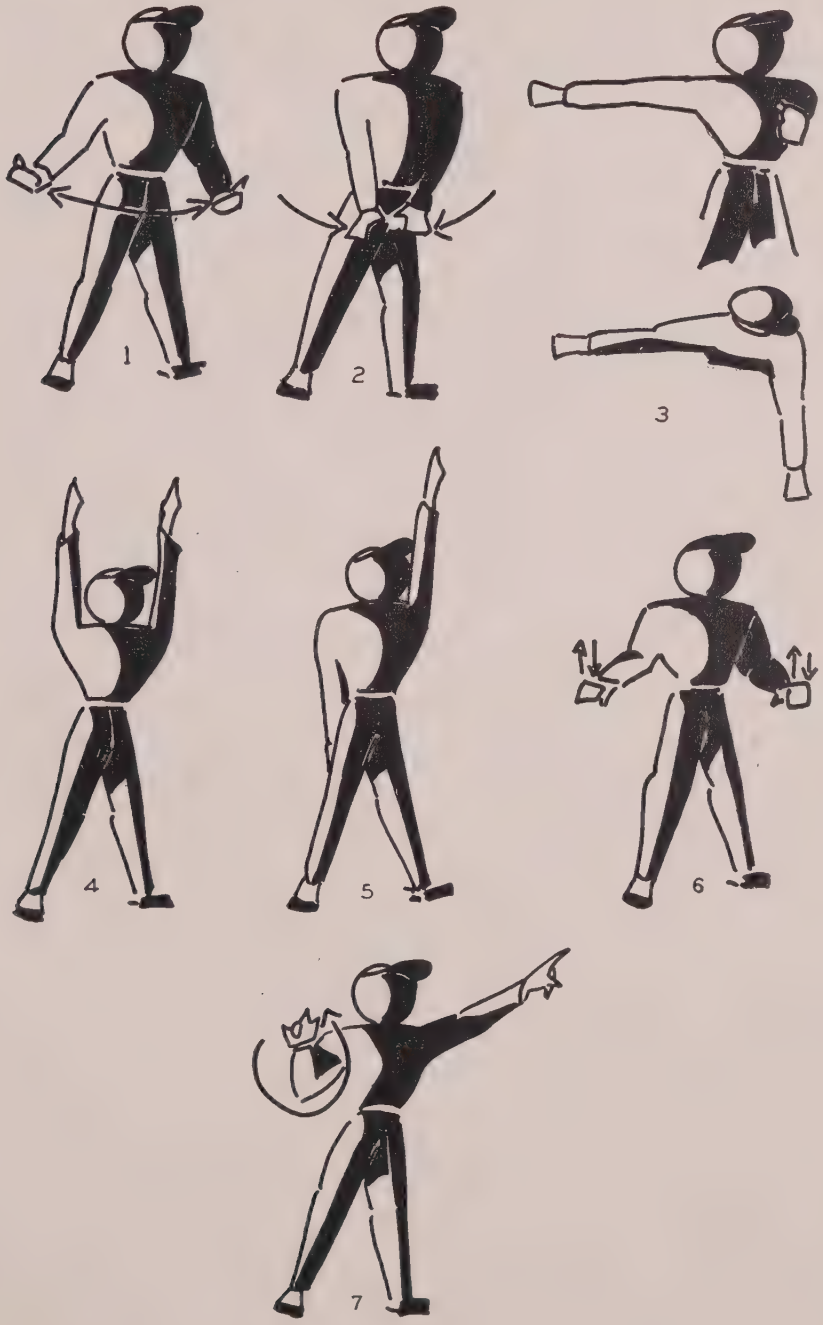
GROUND TO AIR SIGNALS USED IN THE SPRAYING OF INSECTICIDES FOR MOSQUITO ABATEMENT DISTRICT

ROY W. OWEN
Pilot, Merced County (California) Mosquito Abatement District
Drawings by MRS. DOROTHY M. OWEN

The problem of communication between the pilot and the inspector during airspray operations for mosquitoes was a haphazard system of frantic arm waving and loud shouting until the District's pilot, Roy W. Owen, devised a system of visual hand signals. The Merced County Mosquito Abatement District operates three (3) Aeronca airplanes in which all load capacity is reserved for insecticide and spray apparatus leaving none for the inclusion of radio equipment. After the adoption of the standard signals, the efficiency of the aerial spray operations was greatly increased throughout the District.

1. *Fly Swaths Farther Apart*—Arms extended down, thumbs pointed out, arms in an outward movement. This signal is used to show the pilot he is getting an overlap on the spray swaths.
2. *Fly Swaths Closer Together*—Arms extended out from shoulders, thumbs pointed in, arms in an outward movement toward hips. This signal is to show the pilot to fly his swaths closer together, that there is an area between swaths that is not receiving coverage by the spray.
3. *Denoting Boundary of Field to be Sprayed.*—Signal may be given either in the position illustrated showing the corner boundary with arms extended straight out from the shoulders, one forward and one sideward, or with both arms extended sideward denoting the end of the field to be sprayed. When giving this signal the signalman will be standing on the corner boundary when giving the corner boundary signal, and on the end boundary when giving the end of the spray run, and in both cases his extended arms will be pointed parallel with the boundaries of the field he wants sprayed.
4. *Direction of Spray Paths*—Arms above head, then moved to forward extended position. This signal is used to direct the pilot to the best heading on which to fly his spray patterns as determined by the ground man after taking into consideration such factors as wind direction, length of spray run, and obstructions in the line of flight.
5. *Repeat Spray*—One arm extended above head then moved to forward extended position. This signal used to direct the pilot to repeat spray over the swath just completed or in some cases over the entire field or area just completed, in cases of heavy infestation where positive kill is to be assured.
6. *Bring Spray Closer to Ground*—Arms extended at waist level, palms down, short up and down movement of arms from the elbow. This signal directs the pilot to fly the airplane lower to the ground in the event that the temperature or winds have risen; and by lowering the spray, drift of the spray is decreased.
7. *Danger! Obstruction in Line of Flight.*—One arm pointed to danger point, other arm in short circular movement from the elbow—otherwise self explanatory.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A PRELIMINARY REPORT ON THE USE OF DDT EMULSIBLE CONCENTRATE BY A MODIFIED DRIP METHOD FOR *AEDES* CONTROL

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AND
GORDON F. SMITH
Entomologist, Kern Mosquito Abatement District, Bakersfield, California

The Kern Mosquito Abatement District consists of 826 square miles located at the southern end of the San Joaquin Valley of California, with Bakersfield at the approximate center. In its natural state this region is an arid semi-desert. The mean maximum temperatures for the summer months are in the high nineties and the summer means in the low eighties. The normal yearly rainfall is 5.97 inches. The Kern River, which runs through the district from northeast to southwest is dry for a large part of the year but subject to spring floods at the time of the snow pack melt in the Sierra Nevada Mountains.

Normally, this area would have no mosquito problem except along the river where *Aedes* could develop during the spring floods, and *Culex* and *Anopheles* from the time of the floods till the river dries up. However, a highly intensive irrigation type farming has developed, and it is because of this and the influx of population it brought that mosquito control has become necessary both for pest relief and the control of malaria and mosquito borne encephalitis.

The type of irrigation practised in this area may well be referred to as flood irrigation. In the alfalfa and permanent pasture holdings the land is diked off into checks from 50 to 75 feet wide and as long as a half mile. Well and/or river water is poured into the upper ends of these checks and allowed to run to the lower end where it often ponds up in areas of considerable size. It is also common practice to drain from the lower end of checks to other checks in the same field and young larvae are carried with the water. Due to the density of the soil in most of the district, water is also used in great quantities in the growing of cotton, sugar beets and vegetables. In order to wet the ground to a sufficient depth for plant growth, water may be run through one of these fields for 10 to 12 hours. In many cases the excess or tail water is simply allowed to run off onto waste land at the lower end of the field. There are also in the district several large cattle ranches of 10 square miles or more. The land on which these ranches are situated is, with minor exceptions, unimproved. It is diked off in large uneven ponds following the natural land contours, and these ponds are flooded successively from higher to lower levels. During the summer the irrigation cycle for most land except the unimproved pastures is from 10 days to two weeks, multiplying the mosquito control problem many times.

During the latter part of the season the district has, in addition to agriculture, about 7 square miles of duck clubs. These are large diked ponds which are flooded prior to duck hunting season and kept full of water until the season is completed.

All of the above practices lend themselves readily to the development of the flood water type of *Aedes* mosquitoes and, as a point of fact, larvae are commonly found at the rate of two hundred per dip and higher over areas of 100 or more acres. The *Aedes* mosquitoes most commonly found are *Aedes dorsalis* and *Aedes nigromaculis*. During the heat of the summer these *Aedes* develop with great rapidity. The junior author, during one

test in July 1946 recorded *A. nigromaculis* emergence within three and one half days after water had been put on the field. Since DDT is not effective against pupae this makes it necessary, during most of the breeding season, to work on a 2½ to 3 day time margin. The season normally lasts for about 8 to 8½ months.

During the summer of 1946 the Kern Mosquito Abatement District turned almost exclusively to the use of DDT emulsible concentrate for the control of *Aedes* mosquitoes. The only exceptions were in waters highly polluted with animal matter, such as sewer farms and dairy drains, and those cases where it is necessary to try for pupal kill. DDT has been found to be ineffective in both of these instances.

The emulsible material was selected after trial for several reasons. Since it penetrates the water it is not apt to weather off from wind and wave action in open water, and readily kills in dense clumps of grass and other vegetation where the larvae tend to gather. It is clean and easy to handle and lends itself most readily to the use of light power equipment necessary to traverse flooded lands and river bottoms. A crew need carry only a gallon or two of this material under ordinary circumstances and with water readily available from pumps and canals have sufficient larvicide available for a normal day's work.

The district is now using commercial 50 and 100 gallon units for power spraying. These units are mounted on jeeps, and on ½-ton, 4 x 4 trucks purchased from the War Assets Administration. It is at present developing experimentally other light, compact power equipment for field use. For larger water areas, where the use of ground power equipment would be too slow or uneconomical, the district owns two PT-17 Stearman airplanes equipped with 100 gallon tanks and spray booms.

Because of the short time margin and the expense of spraying by power of some of the most constant problems in the district, it was decided to attempt the control of *Aedes* mosquitoes in these places by direct introduction of DDT emulsions into the irrigation water. This was first attempted during the latter part of 1946 season on certain of the duck ponds. Even though a great deal of mechanical difficulty was encountered in the early work with this method, the results were excellent and it was decided to attempt control in this manner on a larger scale in 1947. The emulsible concentrate used until the latter part of the 1947 season was the Military Formula purchased from the War Assets Administration. During the latter part of the 1947 season various proprietary emulsible concentrates were tried.

The first tests made late in the season of 1946 were quite crude, the first type of container being a 5 gallon can with a nail hole in the bottom and a plug to regulate the flow. These cans had to be watched closely since DDT crystal formation at the drip hole stopped the flow quickly. The next attempt was made using 5 gallon cans with plug valve gas cocks brazed into the bottom of the cans. These, too, gave a great deal of trouble due to crystallization of the DDT. However, when the cans were properly maintained the results were such that the inspector was unable to find any larvae whatever in the fields treated. The system was used on the unleveled pastures of a large cattle ranch and about 4 square miles of duck clubs.

Before the 1947 season started, the matter of equipment was again considered. It was felt that the difficulty from crystallization was due to the high concentration of emulsible material necessary in the 5 gallon cans in order to drip sufficient DDT in the water for a kill. With this thought in mind gas cocks were brazed into 50 gallon drums to allow for greater dilution of the emulsible concentrate. However, difficulty was also encountered with this apparatus due to the plugging of the orifice with DDT crystals.

The next step was the use of a simple

siphon from a 50 gallon drum. One-fourth inch I.D. Koroseal tubing was used for the siphon and a screw type laboratory hose clamp was used to regulate the flow of the material. The end of the hose was allowed to float freely in the water. Difficulty was encountered with this device in that the tube tended to seal off at the hose clamp. To eliminate this difficulty the glass tip of an eye-dropper was heated and blown to reduce the orifice to a size which would allow 50 gallons to flow through in 24 hours at about 3 feet of head. This tip was suspended in the irrigation stream. No difficulty was encountered with this apparatus so it was further modified (Fig. 1) as a self-activating siphon. Further refinements are yet to be made on the metering tip and on an apparatus to give a truly constant head.

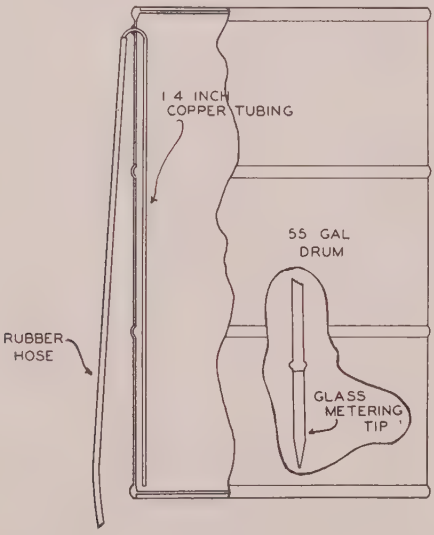

Fig. 1. Diagrammatic Sketch of Siphon Apparatus.

The apparatus as shown in the diagram was used on two large ranches in the district. One consists of 360 acres of improved and irrigated pasture. Well water is used exclusively and the soil is highly alkaline and very tight, holding water on the surface for a considerable period of time. The other ranch is about 400 acres, partially improved and partially unimproved pasture. This ranch uses a combination of well and canal water. This canal water is brought from the river through about 15 miles of open canals. The soil is also highly alkaline and very tight. Both of these ranches are chronic trouble makers and prolific breeders of both *Aedes dorsalis* and *A. nigromaculis*.

The material used for the most part in these tests was the Military Formula. This material was purchased from the War Assets Administration and complete specifications are not available since the amount of emulsifier used was changed several times during the war. When this material is added to water it emulsifies spontaneously giving very fine particles, and remains in a completely and evenly dispersed state for a long period of time. Near the end of the 1947 season the stock of this material was depleted and several proprietary emulsible concentrates were tried but without success. They either broke due to the hardness or alkalinity of the water or rose to the top or settled to the bottom of the drum.

During the summer of 1947 the War Assets xylene concentrate was used quite extensively and met with complete success in nearly all cases.

One hundred per cent kills of emerging larvae appeared to be obtained, as none were found after careful inspection, in any of the fields treated in this manner. Concentrations of 0.15 ppm to 0.55 ppm were used in the tests and the minimum concentration necessary for kill was apparently reached in no case. Results were consistent using 0.15 ppm over a 20 day run on one ranch.

Further, the Military Formula appears highly stable after introduction to the irrigation water. Where 0.15 ppm was used on the ranch irrigated from wells exclusively, the water traveled as far as a mile in the ditch before reaching the portion of the field under irrigation. From the low end of this field the water flowed into a long slough which has, in

previous years, been a source of large numbers of *Culex* mosquitoes. After the siphon drums were set up it was unnecessary to treat this slough in any other manner for a mile and three-tenths below the field. The total carry of the DDT in the water in this case was three and three-tenths miles, including 1 mile of ditch, 1 mile of pasture and 1 and three-tenths miles of slough.

On the ranch using combined canal and well water results were comparable, using 0.15 and 0.16 ppm, to those obtained with well water though the water did not travel as far on this ranch.

Acknowledgment is due Mr. E. H. Hill, Mr. Mark W. Curtis and Mr. Everett Clinton, Inspector-Foremen of the district, without whose constructive suggestions and excellent cooperation in operating these drums and inspecting the treated areas this work would still be only in the formative stages, if it could have been attempted at all.

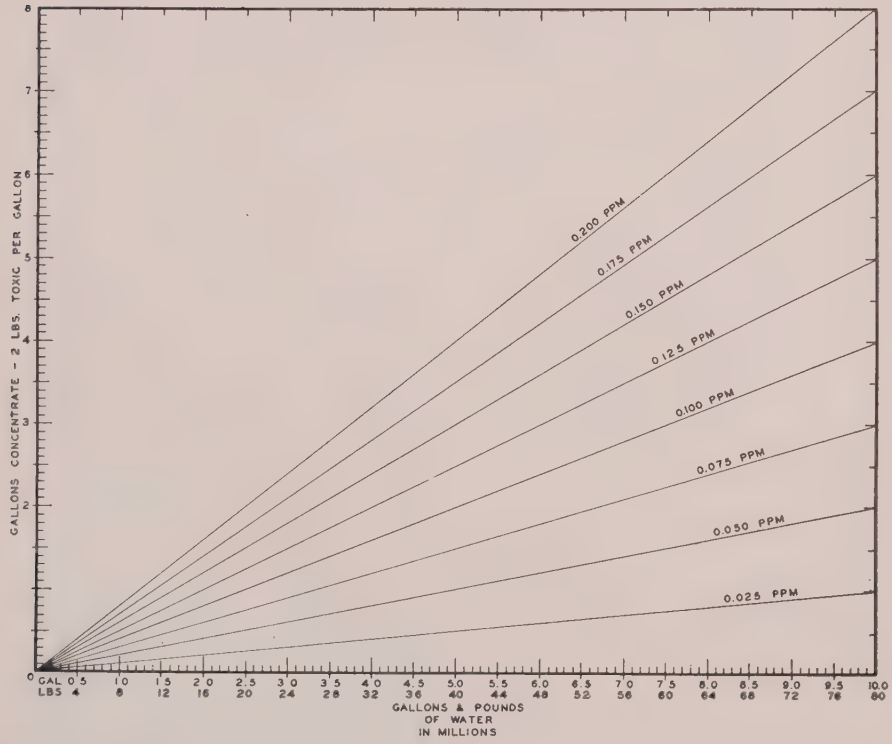

Fig. 2. Control Chart for Applying Toxics by Siphon Method.

A UNIT FOR CATCH BASIN SPRAYING

HERBERT A. CRANDELL, PH.D.

The scarcity of motorcycles in early 1947 and the need for some type of unit for spraying catch basins were the motivating factors which prompted the writer to try the motorized scooter.

The basic unit is a Cushman Motor Scooter, Model 59 chassis. This is a three-wheeled, heavy duty, industrial type of scooter with a load capacity of 300 pounds. A 60-gallon high-pressure tank was mounted between the front wheels in the space provided for the cargo body. The actual mounting was done by welding four "Y" supports to the tank and then bolting the supports to the chassis of the scooter.

The necessary air pressure in the tank for spraying was supplied by a Model 737 Tokheim air compressor (less the base). The compressor was bolt-mounted to an inverted "U" frame over the rear or driving wheel. The "U" frame in turn was weld-mounted to the rear wheel suspension frame of the scooter. To make headroom for the compressor it was necessary to remove the floor of the tool compartment behind the driver's seat.

The compressor was belt-driven from a take-off pulley mounted on the end of the scooter motor crankshaft just outside the air circulating or cooling fan. A section of the left side of the scooter body (see Fig. 1) had to be set out to make room for the take-off pulley and the belt to the compressor. The small box-like structure on the set out section was installed as an air-scoop to overcome overheating difficulties but it proved ineffective and has since been removed.

An idler pulley arrangement permits "cutting" the compressor in or out as desired.

Although two of these scooter units have been in operation for one full season, there still remains some doubt as to whether the unit can "take it." Considerable trouble was experienced the latter part of the season with overheating of the motors—in fact, it became necessary to overhaul them. With the thought that this overheating may have been occasioned by the position of the take-off pulley immediately in front of the air circulating fan, thus interfering with the proper circulation of air across the motor, the take-off pulleys were removed. As it was near the end of the season, however, the scooters were not operated enough to determine if overheating was caused by these pulleys blocking proper air circulation. It is possible that continuous overloading of the scooters by approximately 200 lbs. during the hottest part of the summer may have been the chief cause of this overheating. With the removal of the take-off pulleys and compressors, air pressure for spraying was maintained by the "service-station-stop" method. An initial pressure

FIG. 1. Motor Scooter Catch Basin Spraying Outfit.

of 90 psi was placed on the tank containing 40 gallons (two-thirds full) and when, during the course of spraying activities, the pressure dropped to around 50 psi the operator would pull into a convenient service station and restore the pressure to 90 psi. It was found that only one service station stop was necessary to empty the tank.

Toledo is relatively flat and observations thus far suggest that this type of unit would not prove successful in hilly areas. The scooters are not very satisfactory hill climbers, especially when fully loaded. Should anyone contemplate the use of such a scooter for catch basin spraying, it is suggested they first test it out fully loaded with 300 to 400 pounds (including tank) in addition to the driver and under conditions comparable to which it would be required to operate during spraying activities, including stopping and starting on hills. It is further suggested that the tank size be reduced to 40 gallons and that the larvicide load be limited to 25 gallons to conserve weight. Tanks should also be provided with baffles.

Note: The engineering and installation of the air compressor hookup was done largely by Mr. Frank Irons and his staff of the Bureau of Soils and Agricultural Engineering.

COMPARATIVE TOXICITY OF DDT AND SOME OF THE NEWER INSECTICIDES TO ADULTS OF SALT-MARSH MOSQUITOES [1]

J. A. Fluno, E. S. Raun, C. C. Deonier, and Frank Faulkner [2]
U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine

In tests conducted by Madden *et al.* (1945) and Lindquist *et al.* (1945), DDT sprays applied from airplanes and on the ground showed promise as a means of control for adults of salt-marsh mosquitoes. Similar tests, made during August and September 1946, in which DDT was compared with benzene hexachloride, technical chlordane, and chlorinated camphene, are reported in this paper. All these materials had shown considerable toxicity to house flies and mosquitoes (Slade 1945; Kearns *et al.* 1945). Two samples of benzene hexachloride (gamma isomer contents of about 6 and 12 per cent) were available.

The tests were made in Florida, in densely wooded areas bordering Mosquito Lagoon, just south of New Smyrna Beach, in equally dense jungle bordering Banana River, just north of Cocoa Beach, and in areas at the head of the Indian River near Oakhill and Shiloh. *Aedes taeniorhynchus* (Wied.), *A. sollicitans* (Walk.), and *Psorophora confinnis* (L.-Arr.) were present, the first species being predominant. A few other species, such as *Psorophora ciliata* (F.), were also found in the test areas, but their numbers were insignificant.

Counts of the adult mosquito landing rate (number landing on one man per minute) were made on each plot the afternoon prior to treatment, as a check on the uniformity of the population. Un-

[1] This work was conducted under a transfer of funds from the Office of the Surgeon General, U. S. Army, to the Bureau of Entomology and Plant Quarantine.

[2] Albert N. Davis and E. Nottingham assisted in making these tests.

treated check plots were used to estimate the variation in mosquito populations during the period of the tests. Posttreatment counts were made at various intervals, and the percentage reductions in the treated areas were calculated from the populations in the check plots on the same day.

AIRPLANE APPLICATIONS

Experimental Procedure.—A series of six paired airplane tests were made in densely wooded areas. Each area was bisected by a road leading to a fishing camp along the water front. One side of the road was sprayed with DDT and the opposite side with the insecticide that was to be compared. Each test area included approximately 60 acres.

Except for the benzene hexachloride containing 12 per cent of the gamma isomer, which was compared with DDT at a concentration of 10 per cent (w/v), all the sprays were applied as solutions containing 5 per cent of the insecticide (w/v) in No. 2 fuel oil. At the higher concentration a small amount of cyclohexanone was added as an auxiliary solvent. The applications were made from an N3N-3 airplane equipped with spray bars under the wings. The delivery rate was 2 quarts per acre, and the swath width 100 to 110 feet. Applications were begun at sunrise and finished before weather conditions became too unfavorable for spraying.

Counts were made 2, 6, 10, and 24 hours after the insecticides were applied. They were also made on subsequent days, but these results are not included since the number of mosquitoes infiltrating into the test areas was erratic.

Results.—The results of these tests are given in table 1. In the tests comparing DDT with benzene hexachloride, the percentage reduction in the mosquitoes 2, 6, and 10 hours after treatment was approximately the same for both materials, but after 24 hours DDT was considerably more effective. Apparently this difference is attributable to differences in the residual effect of the two insecticides. The lower reductions for both compounds in the first pair of tests on August 14 were prob-

TABLE 1. Comparative effectiveness of sprays containing DDT and other insecticides when applied by airplane for the control of adult salt-marsh mosquitoes. Delivery rate 2 quarts per acre; 5 per cent solutions in fuel oil unless otherwise indicated.

Date applied	Insecticide	Pretreatment counts (number per man per minute)	Per cent reduction at indicated time following treatment			
			2 hours	6 hours	10 hours	24 hours
1946						
August 8	DDT	97	99	99	99	90
	Benzene hexachloride, gamma isomer 6 per cent	107	99	94	92	29
14	DDT	90	48	57	57	71
	Benzene hexachloride, gamma isomer 6 per cent	103	64	67	37	46
14	DDT [1]	107	85	93	94	94
	Benzene hexachloride [1], gamma isomer 12 per cent	103	86	94	94	68
August 22	DDT	38	85	92	97	87
	Chlorinated camphene	88	17	42	59	27
22	DDT	40	85	92	97	87
	Technical chlordane	80	59	..	85	70
Sept. 11	DDT	292	48	59	77	59
	Technical chlordane	296	38	41	57	50

[1] 10 per cent solution.

ably due to inversion conditions, as the sprays did not settle properly. Technical chlordane was more effective than chlorinated camphene, but both these materials were less effective than DDT.

Crude benzene hexachloride has a strong musty odor, and in these tests it was found that the odor remained in workers' clothing after repeated launderings. Headaches reported by personnel were attributed to this material.

Ground Applications

Experimental Procedure.—Two series of tests were made in which sprays were applied to 1-acre plots in jungle areas having a high adult-mosquito population. One series was made on August 15, in the vicinity of Shiloh, and the other on September 5, near Mims. Each plot was separated from adjoining plots by a 30-yard buffer strip of untreated area. Trails were cut along the margins of the plots to facilitate application of insecticides and subsequent population sampling. The sprays were applied with a 3-gallon pressure sprayer.

Except for two tests, one with a DDT emulsion (25 per cent DDT-xylene emulsion concentrate diluted to 5 per cent by addition of water) and the other with a DDT suspension (5 per cent suspension in water made from 50 per cent wettable DDT dust), all the sprays were applied as solutions containing 5 per cent of the insecticide in No. 2 fuel oil, at the rate of 1 pound per acre of active ingredient. This dosage was lower than the amount needed for a long-lasting residue, but was desirable for experimental purposes in making comparative tests. Two men applied the insecticide while a third directed operations to insure thorough coverage of the ground litter and low-growing vegetation.

Counts were made after 24 hours, and after 4, 5, and 11 days. The counts were made in the afternoon rather than in the morning so that the mosquitoes that had infiltrated into an area during the previous night would be exposed to the residue for a longer time. The investigator took care not to carry into the plots mosquitoes that had been attracted to him while he was in the untreated areas.

Results.—The results of these tests are shown in table 2. In all the plots at Shiloh fairly high reductions occurred within 24 hours after treatment and persisted for 4 to 5 days. Chlorinated camphene seemed to be the least effective. After 11 days none of the treatments except DDT in oil solution and in suspension were effective. Heavy rains during the period of the test may have been responsible for these results. Because of a rapidly declining adult-mosquito population in the general area of Shiloh after 11 days, the observations were terminated.

At Mims dry weather prevailed throughout the observation period except for a rain just after the sprays were applied. In contrast to the tests at Shiloh, all the treatments gave some evidence of residual effect for 11 days. However, the tests at Mims were also terminated after 11 days because of a rapid decline in the mosquito population.

The comparative value of the four compounds as residual treatments appeared to be in the following order: DDT, benzene hexachloride, technical chlordane, and chlorinated camphene.

Summary.—DDT in oil solution, applied as sprays from an airplane, controlled adult salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wied.) and *A. sollicitans* (Walk.), more effectively than did benzene hexachloride, technical chlordane, or chlorinated camphene. Benzene hexachloride of both 6 and 12 per cent gamma isomer content gave immediate reduction of mosquito populations equal to those given by DDT, but after 24 hours the DDT was considerably more effective.

When sprayed on the ground and on low-growing vegetation, during periods of heavy rainfall, 5 per cent of benzene hexachloride, technical chlordane, and chlorinated camphene in No. 2 fuel oil and a 5 per cent DDT emulsion were effective against mosquitoes for 4 to 5 days. DDT applied at the same strength as a suspen-

TABLE 2. Comparative effectiveness of sprays containing DDT and other insecticides applied from the ground for the control of salt-marsh mosquitoes; 5 per cent solutions, in fuel oil unless otherwise indicated.

Treatment	24-hour count		4- to 5-day count		11-day count	
	Number per man per minute	Per cent reduction	Number per man per minute	Per cent reduction	Number per man per minute	Per cent reduction
			Tests at Shiloh — August 15			
DDT:						
Oil solution	11	92	18	85	14	78
Emulsion	16	89	14	89	85	0
Suspension	22	84	12	91	7	89
Chlorinated camphene	50	64	42	68	63	0
Benzene hexachloride, gamma isomer 6 per cent	11	92	30	77	79	0
Technical chlordane	28	79	22	83	87	0
Checks (untreated)	106	..	108	..	29	..
	150	..	130	..	88	..
	150	..	150	..	95	..
Average	135.3	..	129.3	..	70.6	..
			Tests at Mims — September 5			
DDT	6	87	9	82	9	77
Chlorinated camphene	24	53	24	52	28	28
Benzene hexachloride, gamma isomer 6 per cent	18	65	42	16	15	61
Technical chlordane	18	65	21	58	23	41
Checks (untreated)	46	..	55	..	40	..
	56	..	44	..	38	..
Average	51.0	..	49.5	..	39.0	..

sion and in oil solution was effective for at least 11 days under the same conditions. With more favorable weather all four compounds reduced mosquito populations for 11 days, and their comparative value as residual treatments appeared to be in the following order: DDT, benzene hexachloride, technical chlordane, and chlorinated camphene.

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SURFACE BAFFLES FOR MOSQUITO CONTROL

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The problems met where mosquito larvicidal measures are practiced are often quite unforeseen. For instance, very slowly running water can be infested with larvae of *Anopheles*. The slowness of the flow and the irregular shape of the banks may allow breeding even of larvae which usually are found in stagnant waters only. For industrial or agricultural reasons there may be limitations to the use of the basic larvicidal measures such as draining, increasing the slope, etc. (Stitt, 1944).

The procedure described below was developed and applied in central Africa, for control of *Anopheles gambiae* in slowly running water originating from open pit mining and road construction. Oiling of the surface (Matheson, 1929) would have been completely futile as the film would have been carried away by the current before it could act on the larvae.

Therefore, a modification of the oil boom method (Mackie, *et al.*, 1945) was employed with the object of transforming the surface of such slowly running water into an ideal stagnant one, assuring at the same time the normal output of water through the deeper layers of the brook. Such an arrangement permits larvicidal measures such as oiling.

Technique: At intervals of one to five yards, varying with the slope of the brook, laths or sticks, two to three inches wide, were placed across the brook on the surface of the water from one bank to the other. They were immersed in such a way that about one inch was left above the water surface and about one inch was immersed. Where the sticks joined the banks, there were often small spaces through which water (and therefore oil) could flow. To prevent this, these spaces were filled in with handfuls of clay or sand. Water flowed freely beneath these barriers. After the stagnant surface was formed, an oil layer was spread between the surface baffles, using the technique usually applied for stagnant waters.

There may be larvae which sink to the bed of the brook and are carried away by the deep current before being completely asphyxiated, which will eventually be able to rise at another surface to breathe. But they could do so only in swiftly running parts of the brook where they could not survive, or at such a distance from human habitation that their development no longer has epidemiological importance.

To prevent the accidental displacement of the sticks or laths, the superficial barriers should not be left in place indefinitely, but should be removed after the number of hours required to kill the larvae. The whole procedure should be repeated every four to eight days, depending on the larvicidal measures to be used in the stagnant waters of the particular area. After proper instruction, native workers trained in larvicidal measures can carry out this work satisfactorily, but must be checked from time to time.

Resumé. A simple and inexpensive method of changing slowly moving water surfaces into stagnant pools is described. This is brought about by the use of surface baffles which do not interfere with the free run of the water in deeper layers and allow larvicidal oiling of the surfaces.

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NEWS AND NOTES

MOSQUITOES OUT?—Significant results may be expected from a vast operation aimed at complete eradication of malaria-carrying mosquitoes on the island of Sardinia, off the coast of Italy. Quietly sponsored by the Rockefeller Foundation, this $12,000,000 experiment—financed in large part by Italian funds set aside under the Marshall Plan—combines fully mechanized operations with the refinements of scientific control. A path to rich developments in tropical areas may be cleared by the techniques and methods perfected.—W. THOM, *Eng. News Record,* Nov. 18, 1948.

MOUNT VERNON MAD FORMED IN PLACER COUNTY DURING APRIL. It has been recently discovered that a new mosquito abatement district was formed in California, called the Mt. Vernon MAD. The district is approximately 50 square miles in area and includes Penryn, of historical importance in California malarial control.

Mosquito Buzz

In December the Consolidated District instituted a new printed Monthly Work Sheet. It is a combined monthly operational report and material and maintenance report. This report replaces the weekly report which involved too much paper handling. *Mosquito Buzz*

TOMMY MULHERN WAS INTERVIEWED BY JOE BIERS on the "News of the Farm" program over radio station WOR last summer (August 24, to be exact), and took occasion to explain why so many public gatherings in New Jersey have been free of mosquitoes. It seems that spraying the areas with New Jersey larvicide before the outdoor meetings had something to do with it. In response to questions from the interviewer, Tommy went on to mention some of the other manifold activities of New Jersey mosquito control men, and in so doing he performed the valuable service of acquainting the public with some of their headaches and difficulties, which citizens in general sometimes fail to appreciate.

D. L. C.

JAMES ZETEK RECEIVES DECORATION. The Republic of Panama has conferred its highest award, the Vasco Nuñez Balboa decoration, on James Zetek of the Bureau of Entomology and Plant Quarantine who did some of the early work on the malaria mosquitoes of that country and the Canal Zone.

Mr. Zetek has worked in the Canal Zone and the Republic of Panama for 38 years and is the most widely known and best informed scientist in that region. In addition to his work on mosquitoes, he has conducted research on many problems and as resident manager of the Barro Colorado Island natural history preserve and scientific laboratory has done much to promote interest of scientists of many disciplines in the biology of Central America. F. C. BISHOPP

DARLING FOUNDATION TO BE ADMINISTERED BY WORLD HEALTH ORGANIZATION. The Darling Foundation and International Malaria Prize was created by private funds in 1925 in memory of Dr. Samuel T. Darling who was accidentally killed while on a mission for the League of Nations Malaria Commission.

The Darling Fund is to be administered henceforth by WHO, and the Expert Committee on Malaria of WHO is to prepare new statutes for the foundation and will recommend to WHO a candidate for the medal and prize which is awarded periodically to the author of an original contribution to the pathology or prophylaxis of malaria.

Col. S. P. James was the recipient of the award in 1934 and Dr. N. H. Swellengrebel in 1937.

F. C. BISHOPP

If you haven't seen the stationery of the Merced County MAD, we suggest that you find an excuse to write to this California outfit. You might address E. A. Smith, Manager and Entomologist, or Stanley K. Blake, Administrative Ass't.

On the back of the sheet, there is a colored map of the county of Merced, with the industries and resources interestingly and often comically portrayed. Included are gold nuggets, beef cattle, Grade A cows, and happy luscious tomatoes. The lack of even the smallest mosquito, however, leads us to believe that either Merced is not bragging about that kind of fauna, or else that mosquito extermination is virtually complete. Congratulations, boys; we admire your originality and artistry. H. L. T.

The Virginia Mosquito Control Association held its Second Annual Convention, Friday, January 28, 1949, at Old Point Comfort, Va. It was our privilege to be among the approximately 200 members and guests present when President Perry W. Ruth called the meeting to order in the Hotel Chamberlin.

The morning session included the Presidential Address, as well as addresses by high-ranking navy and army officers from the military installations which are so numerous and extensive in that section of Tidewater Virginia. These men stressed the value to mosquito control of cooperation between military and civilian personnel, and expressed appreciation of the work being done by the Virginia Association. The President of the Federation of Garden Clubs of Norfolk and Vicinity presented an outstanding paper entitled, "Mutual relations of Women's Clubs and mosquito control activities."

Luncheon in the Virginia Room was highlighted by the presence of the Hon. Wm. M. Tuck, Governor of the Commonwealth of Virginia. Governor Tuck is a genial man and an enthusiastic speaker, and he gave to the assemblage the feeling that mosquito control has in him a staunch ally.

In the afternoon, technical papers predominated. Some titles were: "A resumé of mosquitoes trapped in 1948"; "Plans for the study of the effect of DDT on blue crabs"; "The jeep as a vehicle for mosquito control"; "A new nozzle for catch basin spraying"; and "The use of small pressure sprayers in mosquito control."

A business session followed. Officers elected and inducted for 1949 were:

President, Stuart M. Gibson—Hampton
1st V. P. W. Payton May—Virginia Beach,
2nd V. P. J. C. Morris—Hilton Village
3rd V. P. L. H. Denny—Portsmouth
Sec.-Treas. Rowland E. Dorer—Norfolk

Perry W. Ruth, who had persistently refused nomination for a third term, turned his gavel over to Stuart Gibson, and retired; and Rowland Dorer on behalf of "some of the boys" presented Ruth with a Parker Pen and Pencil set. The retiring President and members can look back to the two first years of the VMCA as successful and inspirational ones; and they can look ahead to the many more years which lie before them, full of promise and continued success. H. L. T.

The following resolution was drafted by the committee and approved by the association, in recognition of the outstanding services rendered to the Virginia Association by Mr. Ruth.

Whereas, Perry W. Ruth, of Norfolk, Virginia, was unanimously elected and inducted into office on January 24, 1947, as the first President of the Virginia Mosquito Control Association, which he has served for two (2) terms of one (1) year each; and

Whereas, He has contributed towards the success of this Association by his untiring efforts in its development and the continued efficient service he has rendered in its behalf, with loyalty, dignity, and able leadership during the entire tenure of his office: and

Whereas, He is retiring as President of the Association as of this date: therefore be it

Resolved, That the thanks of this Association in convention assembled be extended to Mr. Ruth for the fine conduct of his office and to express the wish that he will be spared for many years to come to continue the excellent work he has accomplished in mosquito control operations, and that he will also continue to take a great interest in the activities of this Association.

Resolved, Further that this resolution be published in the next issue of the "Skeeter," our official organ.

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Committee
R.E.D.

Old Point Comfort, Virginia
January 28, 1949

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EDITORIAL SECTION

THE VALEDICTORIAN

This is the first number of MOSQUITO NEWS to be published, in its present form, without Dr. Glasgow as editor. Under his leadership, MOSQUITO NEWS has grown into an influential scientific journal of international reputation. At the same time, Dr. Glasgow saw to it that the NEWS always had its feet on the ground—almost literally, one might say, in the ditches and machine shops, so that it would be of direct value and service to the man in the field as well as to students of ecology, biology, taxonomy and all the related fields which contribute to a knowledge of mosquitoes and their control.

Dr. Glasgow, as editor, did not confine himself to reviewing manuscripts. In his editorials he was constantly proposing improvements in the organization of the Association, prompted by his realization of the influence, real and potential, that a strong society with a definite purpose could and should wield both within and beyond its special area of knowledge. The incorporation of the Association, and its reorganization to enable it to take fuller advantage of the increased potential for usefulness accruing from its more widely distributed and greatly increased membership constitute, in part, a monument to Dr. Glasgow's persistent editorial advocacy of a strengthened organization.

The Association has been fortunate in having had a succession of more than ordinarily able and interested officers, each of whom, in his own way, has enhanced the standing of the Association. It has been equally fortunate in having as editor of its official publication a man of Dr. Glasgow's comprehensive knowledge, tireless energy and intense and unselfish devotion to the Association and its interests.

In a brief and modest letter to Secretary Mulhern, printed in the December 1948 number of the NEWS, Dr. Glasgow announced his resignation as editor under the heading: "Valedictory." The word implies "a farewell," but the members of the Association will not wish to accept this meaning too literally. Rather will they choose the connotation now accepted through long usage in academic circles in this country, that a Valedictory is essentially a promise of more to come, based on past achievements, made by "the one who ranks first in scholarship" in a group that has successfully completed "a course of study." In this instance the "course" successfully completed is his editorship, over a five-year period, of our publication.

Everyone will also agree that Dr. Glasgow fits the other part of the definition as "one who ranks first in scholarship," and will hope and expect that a part of his achievements to come will be his continued guidance of MOSQUITO NEWS and continued interest in Association affairs.

D. L. C.

THE INTERIM BOARD AND THE REORGANIZATION PROGRAM

Last year at the annual meeting at Ft. Pierce, Florida, the members of the American Mosquito Control Association authorized its incorporation as a non-profit corporation under the laws of New Jersey. After considerable study and planning, the incorporation of the Association has been effected. Temporarily, pending the adoption of by-laws, the corporate Association is being governed by an Interim Board of nine members named in the articles of incorporation.

This Interim Board has two major problems before it, of approximately equal importance and priority. One is the development of by-laws under which the members of the Association can have a direct, decisive part in governing the corporation on a democratic basis with adequate representation of the various geographical areas involved. The other is the problem of placing the Association on a thoroughly sound financial basis so that it can be of maximum benefit to its members.

The Interim Board has set up a definite time schedule for the preparation of an adequate set of by-laws, and their submission to the membership for consideration and suggestions, with opportunity for revision before the final draft is presented for adoption. A large amount of work has already been accomplished by Dr. R. D. Glasgow and his Committee on By-Laws, and at least the principal features of the new by-laws should be approved by the Interim Board which will meet at Atlantic City on March 22. The first draft should be in the hands of the members by June, and the revised final draft should be ready for a vote on adoption by December.

It is imperative that the greatest care be taken in the preparation of these by-laws, under which the Association will be governed. The problem of adequate regional representation of a widely scattered membership is one of the most important matters under consideration. Suggestions from the membership as to how such representation on the governing board can best be effected will be welcomed by the Committee on By-Laws.

Adequately to perform its functions, the Association needs an appreciably increased revenue, which can come from increased membership, increased advertising in "Mosquito News," and other possible sources of revenue now being explored by the Interim Board. This problem will be discussed at a later time when definite decisions have been reached. Time was not available at the California meeting to explore completely the possibilities in this direction.

The California meeting was a success, and developed an increasing enthusiasm for the Association. With good planning plus enthusiasm we can go a long way toward increasing service to our members.

Harold F. Gray

Editor's Note: Official Association news, including the official actions of the Interim Board, the names of members of committees, and news of the California meetings, will be included in the June number. Meanwhile, the official notices and statements on the covers have been changed temporarily to conform to the current status of the organization.

REVIEWS AND ABSTRACTS

BIOTIN AND FAT-SOLUBLE MATERIALS WITH BIOTIN ACTIVITY IN THE NUTRITION OF MOSQUITO LARVAE. By W. Trager. J. Biol. Chem. 176(3): 1211–1223. 1948.

The growth and metamorphosis to the adult stage of *Aedes aegypti* larvae free of microorganisms in a liquid medium of essentially known composition was studied. This medium, differing only slightly from that which had been used in nutrition studies of the fruit-fly, *Drosophila melanogaster,* (Schultz et al, Anat. Rec. *96,* 44, 1946; Villee and Bissel, J. Biol. Chem. *172,* 59, 1948) contained inorganic salts, ribose nucleic acid, cholesterol, sucrose, 1-cysteine, glutathione, choline chloride, all the known B vitamins save biotin, and vitamin-free casein.

Optimum growth of the larvae, as determined by the rapidity of passage through the 4 instars, was obtained when the medium was supplemented with sufficient biotin to contain about 50 mγ (1 mγ equals 10^{-9} gm.) of biotin per milliliter. With lower biotin concentrations, growth was progressively slower. When the concentration of biotin was less than 5 mγ per ml., metamorphosis to the adult did not take place.

Biotin could not be replaced by pimelic acid, which serves as a precursor of this vitamin in the nutrition of the flour beetle, *Tribolium confusum.* However, relatively low concentrations of oleic acid, an oil from hydrolyzed horse plasma (FSF), lecithin, Tween 80 (a polyoxyethylene derivative of sorbitan monooleate), and Tween 40 (a polyoxyethylene derivative of sorbitan monopalmitate) could be substituted for biotin. Since these compounds can at least partially replace biotin, the author suggests that biotin must be of general importance in the synthesis of these lipides.

Further studies of the nutrition of mosquitoes may throw additional light on the role certain dietary essentials play in the metabolic processes of higher animals.—E. S. Josephson, Biochemist, National Institutes of Health, Bethesda, Md.

NOTAS SOBRE A DISTRIBUÇAO E A BIOLOGIA DOS ANOFELINOS DAS REGIAOS NORDESTINA E AMAZONIA DO BRASIL. Deane, L. M., Causey, O. R., and Deane, M. P. 1948. Rev. Serv. Esp. Saude Publ. 1:827–965. This paper is a summary of extensive observations on the anopheline mosquitoes of the Northwest and Amazon regions of Brazil, which were made from 1939–1944. The studies were initiated by the Laboratorio do Servico de Malaria do Nordeste, during the anti-*gambiae* campaign, and after the disappearance of this mosquito at the end of 1940, the program was expanded to include the other anophelines.

Thirty-six species of anophelines were collected. The distribution, seasonal abundance, larval ecology, feeding and resting habits of the adults, and the relation to malaria of each species are described. *Anopheles darlingi* is the most important malaria vector in this region. The distribution of the disease coincides closely with that of *darlingi,* except in certain coastal areas where *A. aquasalis* and *A. albitarsis domesticus* are involved in its transmission. Two varieties of *albitarsis* are recognized: var. *domesticus* is found in houses, while the typical variety prefers to feed on domestic animals and does not take part in malaria transmission. It is suspected that *A. pessoai* Galvao and Lane is a synomym of *A. brasiliensis* Chagas.

Tables are given of the numbers of adults and larvae taken in various localities by several methods of capture. The extent of the work can be appreciated when one notes that totals of 239,787 adults and 920,851 larvae were identified. There is also a table showing the numbers of mosquitoes examined for malaria parasites. *A. darlingi* showed a 1.8 per cent infection in 1600 examined; 0.9 per cent of 1364 *A. aquasalis* and 0.1 per cent of 1508 *A. albitarsis* were also infected. A single infected *A. pessoai* was found among 334 dissected.

Spot maps showing the distribution of all species are included, as well as graphs showing the daily activities of *A. darlingi, albitarsis,* and *aquasalis.*

It is the opinion of the reviewer that this is a valuable contribution to the literature of the Neotropical anophelines. Much of the information has been published elsewhere by the authors, but in this paper one finds a concise summary of the distribution and habits of these important mosquitoes in northern Brazil.—Lloyd E. Rozeboom.

MALARIA IN UTAH. By H. L. Marshall and Don M. Rees. Rocky Mountain Medical Journal 45(6): 469–472, 1948. Although Utah is usually considered to be a malaria-free state, this disease apparently has existed there for over 100 years. From 1900 to 1943 few cases of malaria appear on the records and of these, most of the patients seem to have been newcomers or travellers. During 1942 Utah reported 5 cases of malaria but in 1943, 313 cases were recorded. Even though 30 other states had a rise in malaria during the war years, not one had such a phenomenal increase as Utah. The chief factor in this rise was undoubtedly due to the return of the veterans from World War II. However, since that time there has been a steady decline in malaria and by 1947 only 47 cases were recorded for that year.

Both *vivax* and *falciparum* have been reported from Utah. The malaria vectors found in the state include *Anopheles freeborni* Aitken, found there below a level of 7500 feet, and *A. pseudopunctipennis franciscanus* McCracken. Apparently

all the factors aiding in the spread of malaria are not present in that state, yet the authors suggest the need for mosquito control.—Helen Sollers, (U.S.B.E.P.Q.)

The Development of a Sprayer for Use with Water Suspensions of DDT in Rural Areas of Latin America. By Harold Trapido. Am. J. Trop. Med. 28(5):721–739. 1948. The importance of the use of DDT water suspensions, as contrasted with emulsions or solutions, is outlined from the point of view of logistics of supply, economy, and superior results obtained on earthen wall surfaces commonly encountered in Latin America and elsewhere in the tropics. The need in this area for a simple hand-operated apparatus to dispense water suspensions of DDT, rather than motor-driven equipment, is justified.

The development of a knapsack-type hand-pumped sprayer for use with DDT water suspensions is reported. The basic unit modified for this purpose is the Army item of issue, "Sprayer, Insect, Knapsack Type, Lofstrand Model." The important feature of the new unit is the large capacity filter of #40 wire-screen placed on the end of the outlet pipe where it is protected inside the body of the tank, yet available for cleaning each time the tank is opened for refilling with insecticide. The filter is constructed so that no particles can enter the hose which will either plug the nozzle or cause the gun valve to stick; yet the filter has sufficient capacity not to become plugged itself in evacuating a tankful of DDT mixture.

The sprayer is fitted with interchangeable air-relief valves, one of which may also be used to secure pressure in the tank from a compressed air source, where such is available. With each group of sprayers used by a field crew there is a combination stand-pipe, funnel, and preliminary filter. This provides for the filling of sprayers to a standard level, and reduces wastage in filling the tanks.—Author's summary.

A textbook of Entomology. Ross, H. H. 522 pp., 434 figures. John Wiley & Sons, Inc., New York, 1948. $6.00. The author has prepared a new introductory textbook of entomology which emphasizes the fundamental aspects of the science. Basic principles have been presented rather than detailed information. The first chapter discusses the growth of North American entomology in an interesting fashion; the second deals with arthropoda: insects and their allies—actually most of the space is devoted to arthropods other than insects; the third includes external anatomy; the fourth internal anatomy; the fifth covers physiology in a rather complete manner; the sixth is entitled the life cycle; and the seventh which extends over 200 pages is devoted to the orders of insects—this chapter contains keys to the orders of common insects and under the important orders keys to common families are provided. Condensed within this chapter are important data concerning the most common species or those of economic concern. Chapter eight deals with the geological history of insects: chapter nine with ecological considerations; and chapter ten with control considerations.

The author has presented a book which should adequately serve the needs of beginning students in entomology. It is attractively illustrated with 434 figures, the majority of which are borrowed but both the drawings and photographs are excellently reproduced. Few references are provided in connection with the individual chapters. The review has noted few discrepancies; Comstock initiated teaching of entomology at Cornell in the spring term of 1872; the use of the generic term *Bacillus* on page 493 is antiquated; in discussing the feeding habits of Mallophaga no reference is made to the fact that certain species obtain blood by puncturing the bases of young feathers.

The author is to be congratulated upon the appearance of this textbook which should find ready acceptance in beginning university courses in entomology.—E. Harold Hinman, The University of Oklahoma, Norman, Okla.

Malaria, Filariasis and Yellow Fever in British Guiana. Control by Residual DDT Methods with Special Reference to Progress Made in Eradicating *A. Darlingi* and *Aedes Aegypti* from the Settled Coastlands. By George Giglioli, Mosquito Control Service, Medical Department, Georgetown, Demerara, British Guiana. 226 pp. 1948. Although this monograph will undoubtedly serve as an excellent guide and reference book to mosquito control workers in tropical countries, it is to me mainly an historical marker of the good that can be accomplished in controlling such outstanding health problems as malaria, filariasis, and yellow fever by means of DDT. Dr. Giglioli has recorded in considerable detail three years of research and practical experience with this insecticide. These pioneer investigations were begun in British Guiana in February 1945. I am particularly impressed by the author's optimism in the eradication of *Aedes aegypti* from 200 miles of treated areas after reflecting on our own "attempts" at ousting this mosquito from Florida. I know of no other report which covers control measures for malaria, filariasis and yellow fever by means of DDT residues alone. In fact, emphasis is laid on the fact that hydrological conditions have been ignored and remain as they always have been in the past. All of this is a fine tribute to an excellent project ably directed under difficult conditions of economy and geography. The book is divided into 7 parts with a summary, bibliography, and 2 appendices; the latter having to do with the Public Health Ordinance of British Guiana and mosquito control regulations. Part I, introduction and ecology; Part II, materials, equipment, insecticide dosage and techniques; Part III, malaria; Part IV, Bancroftian filariasis in

British Guiana; Part V, yellow fever control in British Guiana; Part VI, the effect of DDT on house frequenting arthropods and other vermin; Part VII, organization, progress, and cost of DDT campaign. Since basic conditions for mosquito production remain unchanged, Dr. Giglioli points out that DDT control must continue indefinitely to avoid reinfestation from the uncontrollable, uninhabited hinterland.—H. H. Stage, Bureau of Entomology and Plant Quarantine, U. S. Dept. Agric., Washington, D. C.

THE DESIGN AND CONSTRUCTION OF A REGULATED PRESSURE SPRAYER FOR MALARIA CONTROL OPERATIONS. By Louva G. Lenert and W. A. Legwen. Asoc. Interam. de Ingenieria Sanitaria. Ano 1, No. 4, Abril (April) 1948. Objections of varying air pressures and consequent varying discharge rates such as encountered in commercial hand type sprayers were overcome by the construction of a sprayer of new design.

The new sprayer, containing xylol-resistant materials and designated as the "Regulated Pressure" (RP) sprayer, was composed of two thin shell, high-strength steel tanks of equal size and capacity (approximately 2.16 gals.). One tank was used for air storage; the other for emulsion. An air valve was incorporated in the air tank which, in turn, was connected through a stopcock and pressure regulator to the emulsion tank. The filler opening of the emulsion tank was equipped with a commercial pipe-cap fitting onto which had been welded a handle for tightening purposes. The emulsion tank was equipped with a 0.25 in. bottom discharge outlet. A 0.25 in. copper tube protruded approximately 0.75 in. into the emulsion tank from this outlet and thus small quantities of trash and other sediment were retained in the tank. To the outlet were attached the desired length of hose, pipe wand and nozzle. The whole, weighing 19 lbs., was mounted on a single frame and carried knapsack fashion.

In operating the RP sprayer the pressure regulator was set to maintain an air pressure of 40 psi. in the emulsion tank. The stopcock between the two tanks was closed before filling the emulsion tank. After filling, the air tank pressure was restored to at least 85 psi. Air was introduced into the air reservoir by means of a hose from a compressor tank. An initial pressure of 85 psi. in the air reservoir permitted the discharge of the entire contents of the emulsion tank at a uniform pressure of 40 psi. With an initial pressure of 125 psi., two tankfuls of emulsion may be discharged at the prescribed pressure.

In comparison with single compartment sprayers, the demonstrated advantages of the R.P. sprayer are: (a) It permits the discharge of spray solution or emulsion at a uniform pressure and discharge rate. (b) The uniform discharge rate expedites crew training and improves the uniformity and consistency of surface application rates. (c) It requires less judgment and manual labor to operate. (d) Maintenance requirements are less and it may be constructed by an individual agency. (e) It considerably improves the efficiency of manual spraying operations.

As noted by the editor, while the DDT formulation used in this work was a xylol-aqueous emulsion, the equipment should prove quite satisfactory in areas using kerosene solutions or colloidal emulsion-suspensions of DDT. To a lesser extent it may be found suitable for use with spray formulations composed of aqueous suspensions of water-wettable DDT, since these are apt to require continuous agitation and a more complete accessibility of mechanical parts for cleaning.—Bryant E. Rees, Fresno State College, Fresno, Calif., Technical Advisor, Fresno MAD.

RIFT VALLEY FEVER. ISOLATION OF THE VIRUS FROM WILD MOSQUITOES. By K. C. Smithburn, A. J. Haddow, and J. D. Gillett. British J. Exp. Path., 29:107–121, 1948. Since 1937 the Medical Department of the Uganda Protectorate and the International Health Division of the Rockefeller Foundation have jointly supported intensified epidemiological investigations of yellow fever in Bwamba County in the Western Province of Uganda. Bwamba County is small (140 sq. mi.), and about 80 sq. mi. of it is covered with uninhabited dense primeval rain forest, the remainder being fairly intensively cultivated and supporting a population of over 30,000 persons. Incidental to the main problem (yellow fever) 4 hitherto unknown viruses (West Nile, Semliki Forest, Bwamba, and Bunyamwera viruses) have been isolated from wild mosquitoes. The present paper, in addition, records the isolation and identification of 6 strains of Rift Valley fever virus from *Aedes* and *Eretmapodites* spp.

Rift Valley fever is caused by an hepatotropic virus which thus far is known to affect sheep, cattle and man. In inhabited regions, sheep and cattle are believed to be the reservoirs of the disease; but in Bwamba, wild infected mosquitoes were taken in the uninhabited Semliki forest, and a serological survey of humans in nearby inhabited areas, of 72 wild monkeys, a red forest buffalo and a waterbuck yielded only one serum (human) with protective antibodies. Apparently some other wild host must be involved in the epidemiology of the disease in this area.

Rift Valley fever was known as a disease entity of sheep for some time when Daubney, Hudson, and Garnham discovered the virus and demonstrated its infectivity for man in 1931. They suggested mosquito transmission and later showed that the virus could be recovered from mosquitoes several days after an infective feeding. The present paper records the first time that the virus has ever been isolated from wild mosquitoes and a report of successful experimental transmission of the disease by mosquitoes is in press. Mosquito catches were made from January to July 8, 1944 but infected specimens were found only between April 18 and May 27. Since no

apparent epidemic was observed during the study the rôle that mosquitoes play in the epidemiology of the disease still has to be demonstrated.

Study of the epidemiology of the mosquito-borne virus diseases found in Bwamba is complicated by the fact that the mosquito fauna is very varied and includes many rare and little-known species. The adult females of several species are either inseparable or the separating characters so minute as to be almost impossible to see on the living specimen. All the catches were made by hand which, of course, would yield mainly females, and the specimens were identified alive in individual vials without the aid of an anaesthetic. Those who have ever tried to examine a living mosquito through the glass wall of a vial under a microscope will appreciate the difficulties. For these reasons the mosquitoes are referred to "groups" and not to species on the sound assumption, stated in an earlier paper, that it is better to refer a specimen to the correct group than to the wrong species. Virus was isolated from *Eretmapodites* spp., from a complex of *Aedes (Aedimorphus) tarsalis* Newst. and from a species which the authors have tentatively identified as *Aedes (Stegomyia) de-boeri* ssp. *de-meilloni* Edw. However, it is believed that the important vector or vectors are in the Eretmapodites group.

This paper is the latest to appear in a series of studies from a research institute which has as its primary objective the elucidation of the epidemiology of yellow fever. The studies and observations made in Bwamba are undoubtedly leading to that goal and at the same time providing the foundation for further fundamental studies on the interrelationships of viruses.—J. McClintock, Dominion Livestock Insect Laboratory, Lethbridge, Alberta, Canada.

CHRISTIAN COUNTY MOSQUITOES

Eugene Field, 1850–1895

Dr. Cyrus Thomas, formerly of Carbondale, but now connected with the national entomological department at Washington, is temporarily in Illinois, investigating the habits of the mosquitoes that infest that magnificent Christian-county waterway, Flat Branch. By a judicious system of bear-traps exposed along the banks of Flat Branch, Dr. Thomas has possessed himself of a number of handsome specimens of Christian-county mosquitoes, and he is enabled therefore to pursue his researches with uncommon accuracy and ease. His investigations have not progressed to the extent, however, that he is able to declare positively that the Christian-county mosquito is an insect, and not a bird: in fact, there are numerous reasons for believing that these curious and ravenous creatures are a species of reptile, provided, by an inscrutable dispensation of nature, with wings. But his researches have developed many interesting and hitherto unknown facts about these remarkable and remorseless nondescripts. In the first place, the Flat Branch mosquitoes are carnivorous mammals: they nurse their young, and they are provided with incisor and molar teeth for the tearing and masticating of flesh. There is something almost human in the way they wear their beards and moustaches, yet they resemble the equine species in the particular of the spiked shoes with which they are invariably shod when they arrive at maturity, viz., the twenty-first year. In the matter of rearing their young, their habits seem to be like those of the ordinary prairie-chicken, for they retire in the early spring to quiet burrows or corn-fields along Flat Branch, and raise their broods, which have been known to number six hundred souls to one family; in July they become gregarious, and congregate in the timber, roosting in the high trees, and laying waste the human population of the surrounding country. Christian-county huntsmen —notably the Taylorville Sportsman's Association —employ different methods of capturing these destructive creatures. One way is by means of quail-nets; another is the old way of hunting them with pointer-dogs and gun; in the latter case, buckshot is used, and the heaviest kind of fowling piece is preferred. But the most popular method of capture is the pitfall—the same employed to entrap elephants in India. A deep pit is dug, a light covering is thrown over the opening, and on this covering is placed a hindquarter of beef. Attracted thither by the fumes of the meat, the mosquito unsuspectingly steps upon the deceitful pitfall, the slight fabric yields under the leviathan's weight, and with a sickening groan the winged monster is precipitated into his gloomy prison, from which he is not hoisted by his captors till he is enfeebled by captivity and starvation. In this way thousands of mosquitoes are taken annually by the people of Christian county, who derive a handsome profit from the pelts of the mosquitoes, which are tanned into shoe-leather, and the tusks, which are utilized for those varied purposes to which ivory is usually put. Considering the importance of this industry, it is not strange that the results of Dr. Thomas's explorations and researches are awaited with a solicitude bordering upon suspense.—Found and Contributed by Austin W. Morrill, Jr.

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The Missing Meat Safe...

About a hundred years ago, the "meat safe" was a familiar household article in the kitchens of many of the better homes. It was a perforated metal box, used to keep insects from the family's food until it could be cooked and eaten.

When insect wire screening first came into use, the "meat safe" became a wire-screened box. Later, of course, as production and use of insect wire screening increased greatly, and as more and more people learned of its effectiveness in keeping mosquitoes and flies out of the home, the "meat safe" became just an amusing relic of past times.

The fact that it has now vanished from the American scene typifies the great improvements in our living standards, now sometimes taken for granted, and indicates the importance of insect wire screening in helping to raise health and sanitary conditions in the home.

The Insect Wire Screening Bureau is engaged in an informative program planned to emphasize to the public the necessity of mosquito and fly control, and the vital role played by insect wire screening in abating insect nuisance and danger. In this program, constant stress is being placed on the need for *standard* gauge wire—.011" in diameter—and *standard* mesh sizes—16 x 16, 18 x 14 and 18 x 18 mesh—to insure full protection.

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